2021 Year 11 Yearly Examination

Mathematics Advanced

General Instructions	• Working time – 1 hour • Write using black pen • Calculators approved by NESA may be used • A reference sheet is provided at the back of this paper • In Questions 11 – 18, show relevant mathematical reasoning and/or calculations
Total marks: 40	**Section I – 10 marks** (pages 2 – 5) • Attempt Questions 1 – 10 • Allow about 15 minutes for this section **Section II – 30 marks** (pages 6 – 8) • Attempt Questions 11 – 18 • Allow about 45 minutes for this section

Section I

10 marks
Attempt Questions 1 – 10
Allow about 15 minutes for this section

For Questions 1 – 10, select the most appropriate option and write your selection on your answer sheets.

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1 What is $\dfrac{8\times 10}{\sqrt{2021}}$ correct to 4 significant figures?

A. 1.779

B. 1.7795

C. 1.78

D. 1.780

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2 A standard deck of 52 playing cards with four suits (spades, hearts, clubs and diamonds) are shuffled and two cards are drawn at random, one after the other without replacement, what is the probability that the cards are of different suits?

A. $\dfrac{1}{12}$

B. $\dfrac{39}{51}$

C. $\dfrac{39}{52}$

D. $\dfrac{1}{2028}$

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3 What is the value of $\log_4\left(\dfrac{1}{16}\right)$?

A. 2

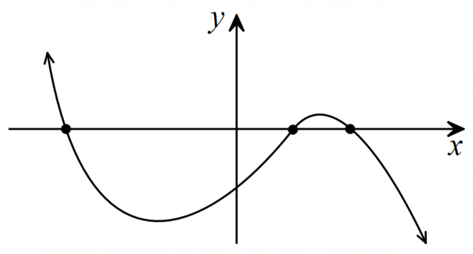
B. 4

C. -2

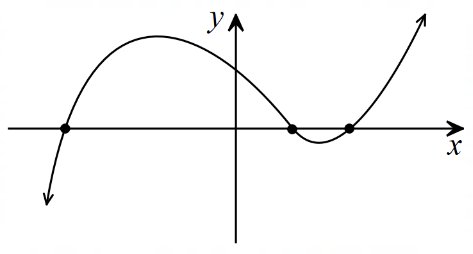
D. -4

4 Which of the following could be the graph of $y=(x-2)(x+3)(1-x)$?

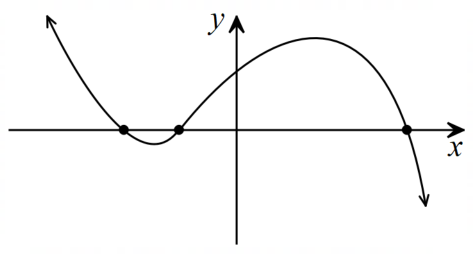
A.



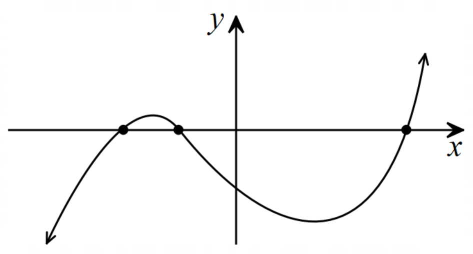
B.



C.



D.



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5 The points $P(3,1)$, $Q(2,5)$ and $R(a,b)$ are collinear. Which of the following statements is correct?

A. $a+4b=7$

B. $a-4b=-1$

C. $4a+b=13$

D. $4a-b=11$

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6 Given $y=4\sqrt{2x-1}$, which of the following is the correct expression for $\frac{dy}{dx}$?

A. $\frac{4}{\sqrt{2x-1}}$

B. $\frac{2}{\sqrt{2x-1}}$

C. $-\frac{4}{\sqrt{2x-1}}$

D. $-\frac{2}{\sqrt{2x-1}}$

7 Given two functions $f(x)=\dfrac{1}{x}$ and $g(x)=x^3$, which of the following expressions **<u>does not</u>** equal to 1?

A. $f(1)g(1)$

B. $f(-1)g(-1)$

C. $f(g(1))$

D. $f(g(-1))$

---

8 Which of the following is equivalent to $1+\cos^4 x-\sin^4 x$?

A. $2\sin^2 x$

B. $2\cos^2 x$

C. $-2\sin^2 x$

D. $-2\cos^2 x$

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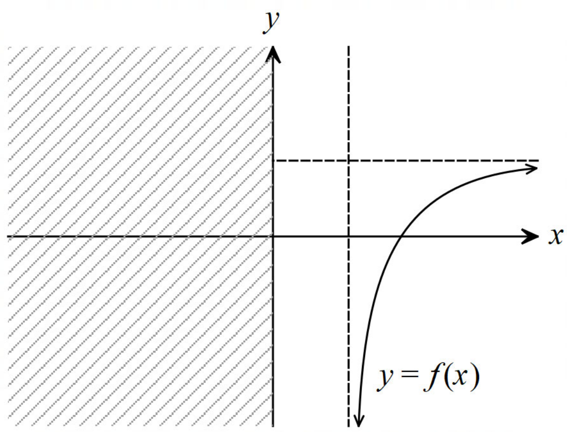
9 Below is an incomplete graph of the relation $y=f(x)$. What lies on the left of the y-axis has been obstructed from view.



Given that $f(x)$ is an odd function, what type of relation is $y=f(x)$?

A. One-to-one

B. One-to-many

C. Many-to-one

D. Many-to-many

10 The straight lines $ax + by + c = 0$ and $dx - ey - f = 0$ are perpendicular, where the coefficients a, b, c, d, e and f are real numbers and are non-zero. Which of the following statements is correct?

A. $ad - be = 0$

B. $ad + be = 0$

C. $ae - bd = 0$

D. $ae + bd = 0$

End of Section I

Section II

30 marks
Attempt Questions 11 – 18
Allow about 45 minutes for this section

Begin your responses for each question by writing down the question number.

In Questions 11 – 18, your responses should include relevant mathematical reasoning and/or calculations.

Question 11 (4 marks)

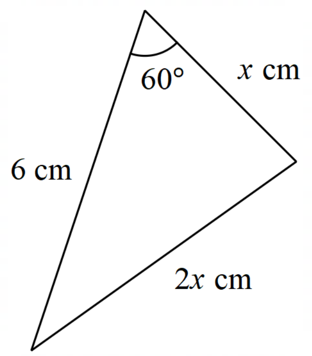
Differentiate each of the following with respect to x.

(a) $\left(3x^2+1\right)^4$ **2**

(b) $\dfrac{x^2}{e^x}$ **2**

Question 12 (5 marks)

Consider the triangle below.



(a) Calculate the exact perimeter of this triangle. **3**

(b) Calculate the exact area of this triangle. **2**

Exam continues on the next page

Question 13 (2 marks)

Find the values of a and b such that $\left(3-\sqrt{8}\right)^2 = a - b\sqrt{2}$. **2**

Question 14 (2 marks)

Sketch the graph of $y = \log_{0.5} x$, showing the x-intercept and at least one other point on the graph. **2**

Question 15 (2 marks)

Solve $2\sin^2 x + \sin x - 1 = 0$ for $0 \le x \le 2\pi$. **2**

Question 16 (5 marks)

Consider the functions $f(x) = \sqrt{x+3}$ and $g(x) = x^2 - 2$.

(a) Write a simplified expression for $g\left(f(x)\right)$. **1**

(b) State the domain and range of $g\left(f(x)\right)$. **2**

(c) Sketch the graph of $y = \left|g\left(f(x)\right)\right|$. **2**

Question 17 (5 marks)

A discrete random variable X has the probability distribution shown below, where a and k are constants. The probability that X takes on the value of x is given by $p(x)$. **5**

x	a	$2a$	$3a$	$4a$
$p(x)$	$\frac{k}{2}$	k^2	$\frac{3k^2}{2}$	$\frac{k}{4}$

Given $E(X) = \frac{19}{4}$, find the values of a and k, and hence evaluate $\mathrm{Var}(X)$.

Exam continues on the next page

Question 18 (5 marks)

A teardrop design is constructed using a circle $\mathcal{C}$ centred at Q and an absolute value function $y = -|mx|$, where m is a positive constant, as shown by the shaded region in the diagram.

The absolute value function is tangential to the circle at points P and R, such that $PQ \perp PO$ and $RQ \perp RO$.

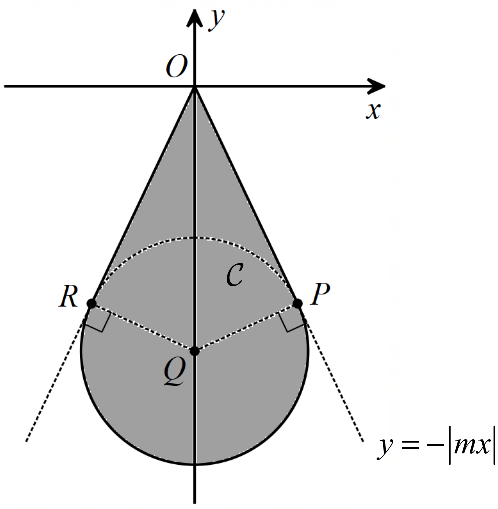


DIAGRAM
NOT DRAWN
TO SCALE

(a) The circle C has equation $x^2 + y^2 + 4y + 3 = 0$. Find the centre and radius of this circle. **2**

(b) Find the value of m. **1**

(c) Calculate the exact area of the teardrop design. **2**

End of Paper

NSW Education Standards Authority

2020 HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Advanced
Mathematics Extension 1
Mathematics Extension 2

REFERENCE SHEET

Measurement

Length

$$l = \frac{\theta}{360} \times 2\pi r$$

Area

$$A = \frac{\theta}{360} \times \pi r^2$$

$$A = \frac{h}{2}(a + b)$$

Surface area

$$A = 2\pi r^2 + 2\pi rh$$

$$A = 4\pi r^2$$

Volume

$$V = \frac{1}{3}Ah$$

$$V = \frac{4}{3}\pi r^3$$

Functions

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For $ax^3 + bx^2 + cx + d = 0$:

$$\alpha + \beta + \gamma = -\frac{b}{a}$$

$$\alpha\beta + \alpha\gamma + \beta\gamma = \frac{c}{a}$$

and $\alpha\beta\gamma = -\frac{d}{a}$

Relations

$$(x - h)^2 + (y - k)^2 = r^2$$

Financial Mathematics

$$A = P(1 + r)^n$$

Sequences and series

$$T_n = a + (n - 1)d$$

$$S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{n}{2}(a + l)$$

$$T_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r} = \frac{a(r^n - 1)}{r - 1},\ r \neq 1$$

$$S = \frac{a}{1 - r},\ |r| < 1$$

Logarithmic and Exponential Functions

$$\log_a a^x = x = a^{\log_a x}$$

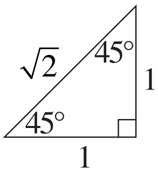
$$\log_a x = \frac{\log_b x}{\log_b a}$$

$$a^x = e^{x \ln a}$$

Trigonometric Functions

$$\sin A = \frac{\text{opp}}{\text{hyp}}, \quad \cos A = \frac{\text{adj}}{\text{hyp}}, \quad \tan A = \frac{\text{opp}}{\text{adj}}$$

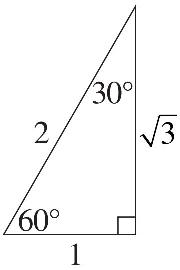
$$A = \frac{1}{2}ab\sin C$$



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$



$$l = r\theta$$

$$A = \frac{1}{2}r^2\theta$$

Trigonometric identities

$$\sec A = \frac{1}{\cos A}, \ \cos A \neq 0$$

$$\operatorname{cosec} A = \frac{1}{\sin A}, \ \sin A \neq 0$$

$$\cot A = \frac{\cos A}{\sin A}, \ \sin A \neq 0$$

$$\cos^2 x + \sin^2 x = 1$$

Compound angles

$$\sin(A + B) = \sin A\cos B + \cos A\sin B$$

$$\cos(A + B) = \cos A\cos B - \sin A\sin B$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A\tan B}$$

If $t = \tan\frac{A}{2}$ then $\sin A = \dfrac{2t}{1+t^2}$

$$\cos A = \frac{1-t^2}{1+t^2}$$

$$\tan A = \frac{2t}{1-t^2}$$

$$\cos A\cos B = \frac{1}{2}\left[\cos(A - B) + \cos(A + B)\right]$$

$$\sin A\sin B = \frac{1}{2}\left[\cos(A - B) - \cos(A + B)\right]$$

$$\sin A\cos B = \frac{1}{2}\left[\sin(A + B) + \sin(A - B)\right]$$

$$\cos A\sin B = \frac{1}{2}\left[\sin(A + B) - \sin(A - B)\right]$$

$$\sin^2 nx = \frac{1}{2}(1 - \cos 2nx)$$

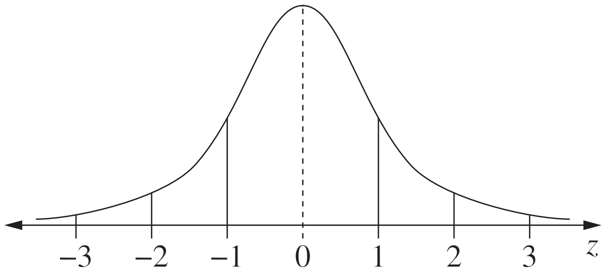
$$\cos^2 nx = \frac{1}{2}(1 + \cos 2nx)$$

Statistical Analysis

$$z = \frac{x - \mu}{\sigma}$$

An outlier is a score
less than $Q_1 - 1.5 \times IQR$
or
more than $Q_3 + 1.5 \times IQR$

Normal distribution



- approximately 68% of scores have z-scores between –1 and 1
- approximately 95% of scores have z-scores between –2 and 2
- approximately 99.7% of scores have z-scores between –3 and 3

$$E(X) = \mu$$

$$\operatorname{Var}(X) = E\left[(X - \mu)^2\right] = E\left(X^2\right) - \mu^2$$

Probability

$$P(A \cap B) = P(A)P(B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}, \ P(B) \neq 0$$

Continuous random variables

$$P(X \leq r) = \int_a^r f(x)\,dx$$

$$P(a < X < b) = \int_a^b f(x)\,dx$$

Binomial distribution

$$P(X = r) = {}^nC_r p^r(1 - p)^{n-r}$$

$$X \sim \operatorname{Bin}(n, p)$$

$$\Rightarrow \quad P(X = x)$$

$$= \binom{n}{x}p^x(1 - p)^{n-x}, \ x = 0, 1, \ldots, n$$

$$E(X) = np$$

$$\operatorname{Var}(X) = np(1 - p)$$

Differential Calculus

Function	Derivative
$y = f(x)^n$	$\dfrac{dy}{dx} = nf'(x)[f(x)]^{n-1}$
$y = uv$	$\dfrac{dy}{dx} = u\dfrac{dv}{dx} + v\dfrac{du}{dx}$
$y = g(u)$ where $u = f(x)$	$\dfrac{dy}{dx} = \dfrac{dy}{du} \times \dfrac{du}{dx}$
$y = \dfrac{u}{v}$	$\dfrac{dy}{dx} = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$
$y = \sin f(x)$	$\dfrac{dy}{dx} = f'(x)\cos f(x)$
$y = \cos f(x)$	$\dfrac{dy}{dx} = -f'(x)\sin f(x)$
$y = \tan f(x)$	$\dfrac{dy}{dx} = f'(x)\sec^2 f(x)$
$y = e^{f(x)}$	$\dfrac{dy}{dx} = f'(x)e^{f(x)}$
$y = \ln f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{f(x)}$
$y = a^{f(x)}$	$\dfrac{dy}{dx} = (\ln a)f'(x)a^{f(x)}$
$y = \log_a f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{(\ln a)f(x)}$
$y = \sin^{-1} f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{\sqrt{1-[f(x)]^2}}$
$y = \cos^{-1} f(x)$	$\dfrac{dy}{dx} = -\dfrac{f'(x)}{\sqrt{1-[f(x)]^2}}$
$y = \tan^{-1} f(x)$	$\dfrac{dy}{dx} = \dfrac{f'(x)}{1+[f(x)]^2}$

Integral Calculus

$$\int f'(x)[f(x)]^n dx = \frac{1}{n+1}[f(x)]^{n+1} + c$$

where $n \neq -1$

$$\int f'(x)\sin f(x)\,dx = -\cos f(x) + c$$

$$\int f'(x)\cos f(x)\,dx = \sin f(x) + c$$

$$\int f'(x)\sec^2 f(x)\,dx = \tan f(x) + c$$

$$\int f'(x)e^{f(x)} dx = e^{f(x)} + c$$

$$\int \frac{f'(x)}{f(x)} dx = \ln|f(x)| + c$$

$$\int f'(x)a^{f(x)} dx = \frac{a^{f(x)}}{\ln a} + c$$

$$\int \frac{f'(x)}{\sqrt{a^2 - [f(x)]^2}} dx = \sin^{-1}\frac{f(x)}{a} + c$$

$$\int \frac{f'(x)}{a^2 + [f(x)]^2} dx = \frac{1}{a}\tan^{-1}\frac{f(x)}{a} + c$$

$$\int u\frac{dv}{dx}dx = uv - \int v\frac{du}{dx}dx$$

$$\int_a^b f(x)\,dx$$

$$\approx \frac{b-a}{2n}\Big\{f(a) + f(b) + 2\big[f(x_1) + \cdots + f(x_{n-1})\big]\Big\}$$

where $a = x_0$ and $b = x_n$

Combinatorics

$${}^{n}P_r = \frac{n!}{(n-r)!}$$

$$\binom{n}{r} = {}^{n}C_r = \frac{n!}{r!\,(n-r)!}$$

$$(x+a)^n = x^n + \binom{n}{1}x^{n-1}a + \cdots + \binom{n}{r}x^{n-r}a^r + \cdots + a^n$$

Vectors

$$\left|\underset{\sim}{u}\right| = \left|x\underset{\sim}{i} + y\underset{\sim}{j}\right| = \sqrt{x^2+y^2}$$

$$\underset{\sim}{u} \cdot \underset{\sim}{v} = \left|\underset{\sim}{u}\right|\left|\underset{\sim}{v}\right|\cos\theta = x_1x_2 + y_1y_2,$$

where $\underset{\sim}{u} = x_1\underset{\sim}{i} + y_1\underset{\sim}{j}$

and $\underset{\sim}{v} = x_2\underset{\sim}{i} + y_2\underset{\sim}{j}$

$$\underset{\sim}{r} = \underset{\sim}{a} + \lambda\underset{\sim}{b}$$

Complex Numbers

$$\begin{aligned} z = a + ib &= r(\cos\theta + i\sin\theta) \\ &= re^{i\theta} \end{aligned}$$

$$\begin{aligned} \left[r(\cos\theta + i\sin\theta)\right]^n &= r^n(\cos n\theta + i\sin n\theta) \\ &= r^n e^{in\theta} \end{aligned}$$

Mechanics

$$\frac{d^2x}{dt^2} = \frac{dv}{dt} = v\frac{dv}{dx} = \frac{d}{dx}\left(\frac{1}{2}v^2\right)$$

$$x = a\cos(nt+\alpha) + c$$

$$x = a\sin(nt+\alpha) + c$$

$$\ddot{x} = -n^2(x-c)$$

YEAR 11 YEARLY EXAMINATION 2021
MATHEMATICS ADVANCED
MARKING GUIDELINES

Section I

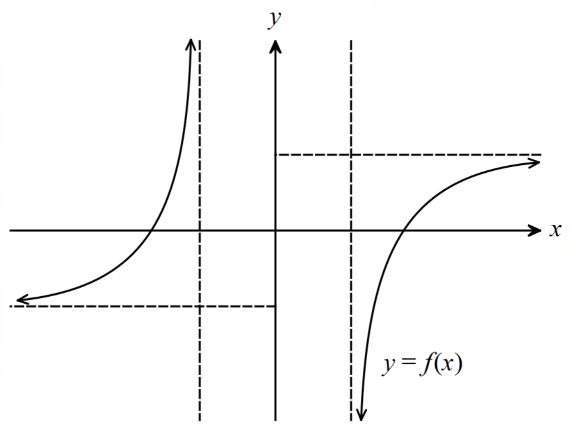
Multiple-choice Answer Key

Question	Answer
1	D
2	B
3	C
4	A
5	C

Question	Answer
6	A
7	D
8	B
9	C
10	A

Questions 1 – 10

Sample solution	
1.	$\frac{8\times 10}{\sqrt{2021}}=1.779536...$ $=1.780 \ \ (4 \text{ sig. fig.})$
2.	$P(\text{different suits})=\frac{52}{52}\times\frac{39}{51}$ $=\frac{39}{51}$
3.	$\log_4\left(\frac{1}{16}\right)=\log_4\left(4^{-2}\right)$ $=-2$
4.	The roots are at $x=-3, x=1, x=2$. Leading term is $-x^3$.
5.	$m_{PQ}=\frac{5-1}{2-3}$ $=-4$ $m_{PR}=-4$ $\frac{b-1}{a-3}=-4$ $b-1=-4a+12$ $4a+b=13$
6.	$y=4\sqrt{2x-1}$ $=4(2x-1)^{\frac{1}{2}}$ $\frac{dy}{dx}=4\times\frac{1}{2}(2x-1)^{-\frac{1}{2}}\times 2$ $=\frac{4}{\sqrt{2x-1}}$
7.	$f(1)\times g(1)=\frac{1}{1}\times 1^3$ $=1$ $f(-1)\times g(-1)=\frac{1}{-1}\times(-1)^3$ $=1$ $f(g(1))=f(1^3)$ $=f(1)$ $=\frac{1}{1}$ $=1$ $f(g(-1))=f\left((-1)^3\right)$ $=f(-1)$ $=\frac{1}{-1}$ $=-1$

Sample solution			
8.	$1+\cos^4 x-\sin^4 x = 1+\left(\cos^2 x+\sin^2 x\right)\left(\cos^2 x-\sin^2 x\right)$ $= 1+1\times\left[\cos^2 x-\left(1-\cos^2 x\right)\right]$ $= 1+2\cos^2 x-1$ $= 2\cos^2 x$		
9.	 "Many" inputs (x-values) can output to the same y-value, this is a many-to-one relation.		
10.	$ax+by+c=0$ $by=-ax-c$ $y=-\frac{a}{b}x-\frac{c}{b}$	$dx-ey-f=0$ $-ey=-dx+f$ $y=\frac{d}{e}x-\frac{f}{e}$	Since the lines are perpendicular: $-\frac{a}{b}\times\frac{d}{e}=-1$ $\frac{ad}{be}=1$ $ad=be$ $ad-be=0$

Section II

Question 11

Sample solution		Suggested marking criteria
(a)	$\frac{d}{dx}\left(3x^2+1\right)^4 = 4\times\left(3x^2+1\right)^3\times 6x$ $= 24x\left(3x^2+1\right)^3$	• 2 – correct derivative • 1 – correctly applies chain rule – obtains $4\left(3x^2+1\right)^3$
(b)	$\frac{d}{dx}\left(\frac{x^2}{e^x}\right) = \frac{2xe^x - x^2e^x}{\left(e^x\right)^2}$ $= \frac{xe^x(2-x)}{\left(e^x\right)^2}$ $= \frac{x(2-x)}{e^x}$	• 2 – correct derivative • 1 – attempts to use the quotient rule

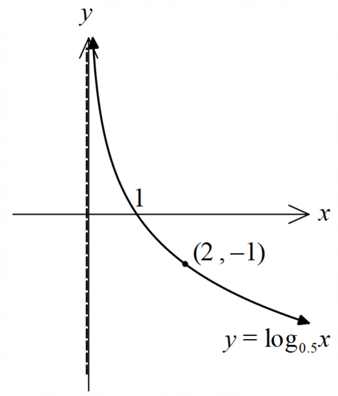
Question 12

Sample solution		Suggested marking criteria
(a)	$(2x)^2 = x^2 + 6^2 - 2\times x\times 6\times\cos 60°$ $4x^2 = x^2 + 36 - 6x$ $3x^2 + 6x - 36 = 0$ $x^2 + 2x - 12 = 0$ $(x+1)^2 - 13 = 0$ $x + 1 = \pm\sqrt{13}$ $x = -1 + \sqrt{13}\quad(\text{since } x > 0)$ $P = 3x + 6$ $= 3\left(-1+\sqrt{13}\right) + 6$ $= \left(3\sqrt{13}+3\right)$ cm	• 3 – correct solution • 2 – correct value of x • 1 – forms a correct quadratic equation in terms of x
(b)	$A = \frac{1}{2}\times 6\times x\times\sin 60°$ $= 3\times\left(-1+\sqrt{13}\right)\times\frac{\sqrt{3}}{2}$ $= \left(\frac{3\sqrt{39}-3\sqrt{3}}{2}\right)$ cm^2	• 2 – correct solution • 1 – uses the sine area rule

Question 13

Sample solution	Suggested marking criteria
$\left(3-\sqrt{8}\right)^2 = 9 - 6\sqrt{8} + 8$ $= 17 - 6\times 2\sqrt{2}$ $= 17 - 12\sqrt{2}$ $\therefore a = 17, b = 12$	• 2 – correct solution • 1 – correctly expands the perfect square

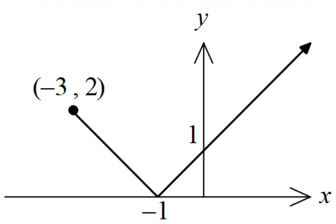
Question 14

Sample solution	Suggested marking criteria
	• 2 – correct graph • 1 – recognises the shape of the graph of a logarithmic function with correct x-intercept

Question 15

Sample solution	Suggested marking criteria
$2\sin^2 x+\sin x-1=0$ $(2\sin x-1)(\sin x+1)=0$ $\sin x=\frac{1}{2}$ $\quad\quad$ $\sin x=-1$ $x=\frac{\pi}{6},\frac{5\pi}{6}$ $\quad\quad$ $x=\frac{3\pi}{2}$ $\therefore x=\frac{\pi}{6},\frac{3\pi}{2},\frac{5\pi}{6}$	• 2 – correct solution • 1 – correctly solves for one angle using a valid method

Question 16

Sample solution		Suggested marking criteria
(a)	$g(f(x))=g\left(\sqrt{x+3}\right)$ $=\left(\sqrt{x+3}\right)^2-2$ $=x+3-2$ $=x+1$	• 1 – correct solution
(b)	$f(x)$ has a natural domain of $x\geq -3$ Therefore, for $g(f(x))$: Domain: $x\geq -3$ Range: $y\geq -2$	• 2 – correct solution • 1 – correct domain only – correct range only
(c)	$y=\lvert g(f(x))\rvert$ $y=\lvert x+1\rvert$, where $x\geq -3$ 	• 2 – correct graph • 1 – recognises the shape of $y=\lvert x+1\rvert$

Question 17

<table>
<tr><th>Sample solution</th><th>Suggested marking criteria</th></tr>
<tr><td>

$$\sum p(x) = 1$$
$$\frac{k}{2} + k^2 + \frac{3k^2}{2} + \frac{k}{4} = 1$$
$$2k + 4k^2 + 6k^2 + k = 4$$
$$10k^2 + 3k - 4 = 0$$
$$(5k+4)(2k-1) = 0$$
$$k = \frac{1}{2} \quad (\text{since } k \geq 0)$$

$$E(X) = \sum xp(x)$$
$$\frac{19}{4} = a \times \frac{k}{2} + 2a \times k^2 + 3a \times \frac{3k^2}{2} + 4a \times \frac{k}{4}$$
$$= a \times \frac{1}{4} + 2a \times \frac{1}{4} + 3a \times \frac{3}{2} \times \frac{1}{4} + 4a \times \frac{1}{8}$$
$$= \frac{a}{4} + \frac{a}{2} + \frac{9a}{8} + \frac{a}{2}$$
$$= \frac{2a + 4a + 9a + 4a}{8}$$
$$= \frac{19a}{8}$$
$$a = 2$$

The probability distribution table becomes:

x	2	4	6	8
$p(x)$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{8}$

$$\text{Var}(X) = E(X^2) - (E(X))^2$$
$$= \left[\sum x^2 p(x)\right] - (E(X))^2$$
$$= 2^2 \times \frac{1}{4} + 4^2 \times \frac{1}{4} + 6^2 \times \frac{3}{8} + 8^2 \times \frac{1}{8} - \left(\frac{19}{4}\right)^2$$
$$= \frac{63}{16} \text{ or } 3.9375$$

</td><td>

5 marks awards for the following:

2 marks for the value of k

- 2 – correct value of k
- 1 – recognises that $\sum p(x) = 1$ and solves a suitable quadratic

2 marks for the value of a

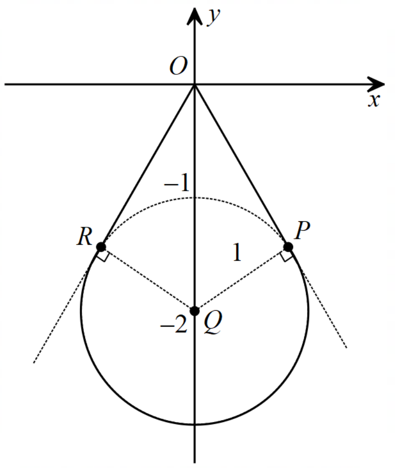
- 2 – correct value of a
- 1 – attempts to use the expected value to evaluate a

1 mark for $\text{Var}(X)$

- 1 – correct value for $\text{Var}(X)$

</td></tr>
</table>

Question 18

Sample solution		**Suggested marking criteria**
(a)	$x^2+y^2+4y+3=0$ $x^2+(y+2)^2-4+3=0$ $x^2+(y+2)^2=1$ $\therefore$ Centre $=(0,-2)$, radius $=1$	• 2 – correct solution • 1 – correct centre – correct radius
(b)	Diagram drawn to scale:  $\cos\angle OQP=\dfrac{PQ}{OQ}$ $=\dfrac{1}{2}$ $\angle OQP=60°$ In ΔOQP, $\angle POQ=30°$ Therefore, OP is at an angle of $60°$ below the positive x-axis, using $m=\tan\theta$ and the fact that OP has gradient $-m$: $-m=\tan(-60°)$ $-m=-\tan 60°$ $m=\sqrt{3}$	• 1 – correct value for m
(c)	$A_{\Delta POQ}=\dfrac{1}{2}\times OQ\times PQ\times\sin\angle OQP$ $=\dfrac{1}{2}\times 2\times 1\times\sin 60°$ $=\dfrac{\sqrt{3}}{2}$ sq. units Similarly, $A_{\Delta ORQ}=\dfrac{\sqrt{3}}{2}$ sq. units Reflex $\angle RQP=\dfrac{4\pi}{3}$ radians $A_{\text{major sector}}=\dfrac{1}{2}\times 1^2\times\dfrac{4\pi}{3}$ $=\dfrac{2\pi}{3}$ $A_{\text{teardrop}}=2\times\dfrac{\sqrt{3}}{2}+\dfrac{2\pi}{3}$ $=\left(\sqrt{3}+\dfrac{2\pi}{3}\right)$ sq. units	• 2 – correct solution • 1 – calculates the area of the major sector – calculates the area of the quadrilateral $ORQP$